the rotation of D is made constant and the movement of the paper is made variable, the same result will be secured. Finally, if the crank pin itself independently changes its radial distance from the axis of D, the amplitude of the curve will be modified, and if in this motion of the crank pin, P, it passes across the center of the revolving disk, D, the effect on the trace is as if the phase of the harmonic trace had changed 180°.

The equation proposed by Fujiwhara[2] is

$$x = A(t) \sin \frac{2n}{P(t)} (t + e(t)).$$

This, so far as I know, is the first effort any of the mathematicians have made to analyze the problem of periodicities with variable length and amplitude. As soon as this paper came to my attention, my mechanical device for tracing variable periodicities led me to point out the fact that Fujiwhara's equation has a redundancy of variables, especially if he makes the phase variable. To do the latter in my mechanical model means that the crank pin, P, must have not only radial motion but also circumferential motion, and we then at once have any particular position of the stylus, S, defined by two or more possibilities, namely, acceleration or deceleration of the disk, coupled with either change of radius or change in the circumferential position of the crank pin. This concept of variable phase angle impresses me as an undesirable redundancy in Fujiwhara's equation, and I would replace that term by a constant phase angle.

[2] Jour. Faculty of Sci. Imp. Univ. of Tokyo. Sec. 1, vol. 1, pt. 10, p. 392.

I have already mentioned that variation in the length of the period can be secured either by accelerating and retarding the forward motion of the paper on which the record is traced, or retaining uniform forward motion for the paper variable lengths of period result from acceleration and retardation of rotation of D. We are, therefore, at liberty to choose either one of these.

Finally, I mentioned that if the radial motion of the crank pin carries it across the center of D it has the effect of sudden change of phase of 180°. I therefore imagine our conception of these periodic curves in nature is best represented by radial motion of the crank pin only from the center outward, although some writers seem to claim they constantly find the phase of their cycle curves change 180°. If this is actually the case in nature it is represented in the mechanical model in the way I have indicated.

You can see, of course, that with only one disk and one slide "A," any curve can be represented by movements of the crank pin in and out from the center, combined with variable paper on disk speeds. This is a vastly simpler concept of periodic motions in nature than to suppose such natural periodicities are made up of a multitude of harmonic elements. However, I think we should not require one mechanical model of this kind to represent all the details of a complex periodic curve, but rather the problem is to find a comparatively few elements having individual and separate variable amplitudes and periods of their own, which in combination produce the complex curve nature gives us.

THE WEATHER OF 1929 IN THE UNITED STATES

551.506 (73)

By ALFRED J. HENRY

Temperature, Chart 1.—Area alone considered, the year must be ranked as a moderately cool one, largely due to low temperatures in parts of the country in January, February, April, May, and September; in both Atlantic and Pacific coast States, however, mean temperature was above normal and there was also a small area of above-normal temperature in the Southwest as shown by the chart. The departures from normal rarely equaled or exceeded 2° F. (See Table 1.).

Precipitation, Chart 2.—The outstanding feature in the distribution of precipitation was the severe drought in Pacific coast and Plateau States, which happily ended in December in that region, southern California alone excepted, and it has since ended there.

The South Atlantic States and both Alabama and Tennessee experienced the second year of excessive precipitation, Tennessee excepted. The heavy precipitation in the South Atlantic and East Gulf States was due in great measure to the occurrence of two tropical cyclones within a short space of time. (See Table 2.) Following is quoted from Weekly Weather and Crop Bulletin of January 14, 1930:

> During the growing season there were two outstanding adverse conditions with regard to rainfall. Too much moisture was harmful in the early spring in most central valley sections and greatly delayed the planting of corn; later in the season, especially during the latter part of July and in August, many sections had damaging drought. The latter was most severe between the Mississippi River and Rocky Mountains, but was generally widespread in character, and, as a result spring planted crops were rather widely damaged. * * *

TABLE 1.—*Monthly and annual temperature departures, 1929*

District	January	February	March	April	May	June	July	August	September	October	November	December	Average
New England	+0.5	+1.7	+4.8	+0.4	+1.3	+1.1	−0.4	−1.5	+1.6	−1.1	+1.5	−0.6	+0.8
Middle Atlantic	+1.2	+0.1	+6.7	+3.1	−0.5	+0.1	−0.6	−1.7	+1.4	−2.0	+1.4	+1.4	+0.9
South Atlantic	+3.0	−1.0	+4.8	+3.3	−0.4	−1.3	−1.2	−0.1	−0.2	−1.4	+1.8	+0.2	+0.6
Florida Peninsula	+3.3	+3.9	+3.2	+3.2	+1.6	−0.3	−1.1	+0.2	+0.6	−2.0	+3.5	+0.1	+1.4
East Gulf	+2.8	−2.8	+3.9	+3.5	0.0	−0.9	−0.8	+0.7	−0.4	−1.4	−0.4	−1.5	+0.2
West Gulf	+1.0	−7.4	+3.0	+3.7	−1.2	0.0	−0.6	+1.8	+0.9	+1.2	−6.0	+0.6	−0.2
Ohio Valley and Tennessee	−1.0	−5.0	+5.9	+3.3	−2.2	−1.6	−0.5	−2.2	−0.1	−2.0	−2.1	+0.6	−0.6
Lower Lakes	−1.3	−1.8	+7.9	+2.9	−1.9	−1.4	−0.1	−2.6	+1.2	−1.9	−1.2	−1.5	−0.1
Upper Lakes	−6.2	−4.1	+6.0	+2.4	−2.2	−2.4	+0.6	−1.0	−0.3	−0.8	−3.0	−1.4	−1.0
North Dakota	−9.3	−4.6	+8.2	+0.8	−4.6	−0.9	+2.6	+3.2	−4.5	+3.2	−1.6	−1.2	−0.7
Upper Mississippi Valley	−7.8	−6.7	+5.8	+2.3	−3.1	−2.2	+0.4	−0.7	−1.5	−0.2	−4.0	+0.6	−1.4
Missouri Valley	−7.2	−7.1	+5.8	+2.2	−2.2	−1.3	+1.5	+2.3	−2.7	+1.2	−4.5	+1.7	−0.9
Northern Slope	−8.5	−8.0	+3.7	−1.7	−1.8	−0.5	+3.0	+5.0	−4.4	+2.5	−3.7	+2.3	−1.0
Middle Slope	−3.1	−8.0	+2.9	+1.8	−2.3	+0.5	+1.0	+2.4	−1.8	+0.6	−7.2	+3.2	−0.8
Southern Slope	+0.7	−6.6	+1.0	+3.1	−2.3	+1.5	−0.4	+2.7	+0.2	+1.3	−7.0	+1.6	−0.4
Southern Plateau	−0.2	−3.5	−0.4	−0.5	+1.2	+1.4	+1.4	+1.2	+1.5	+2.5	−1.4	+4.2	+0.6
Middle Plateau	−2.5	−6.3	−0.4	−3.7	+1.4	−0.1	+2.7	+3.1	−1.0	+2.6	−1.9	+7.0	+0.1
Northern Plateau	−8.6	−10.7	+0.8	−3.4	+0.5	−0.6	+1.7	+4.9	−2.2	+2.7	−3.4	+5.6	−1.1
North Pacific	−4.3	−4.0	+0.4	−2.8	+0.2	+0.2	+0.9	+1.5	+1.8	+3.6	−0.8	+2.5	−0.1
Middle Pacific	−3.1	−1.4	0.0	−2.6	+0.5	+1.5	+1.1	+1.5	+0.5	+2.2	+1.2	+3.4	+0.4
South Pacific	−0.8	−1.6	−0.3	−2.0	+2.3	+0.8	+0.9	+3.1	+1.1	+4.0	+3.4	+4.9	+1.3
United States	−2.4	−4.0	+3.5	+0.9	−0.7	−0.3	+0.6	+1.1	−0.4	+0.7	−1.7	+1.6	[1] −0.1

[1] Annual departure.

TABLE 2.—*Precipitation departures, monthly and annual, 1929*

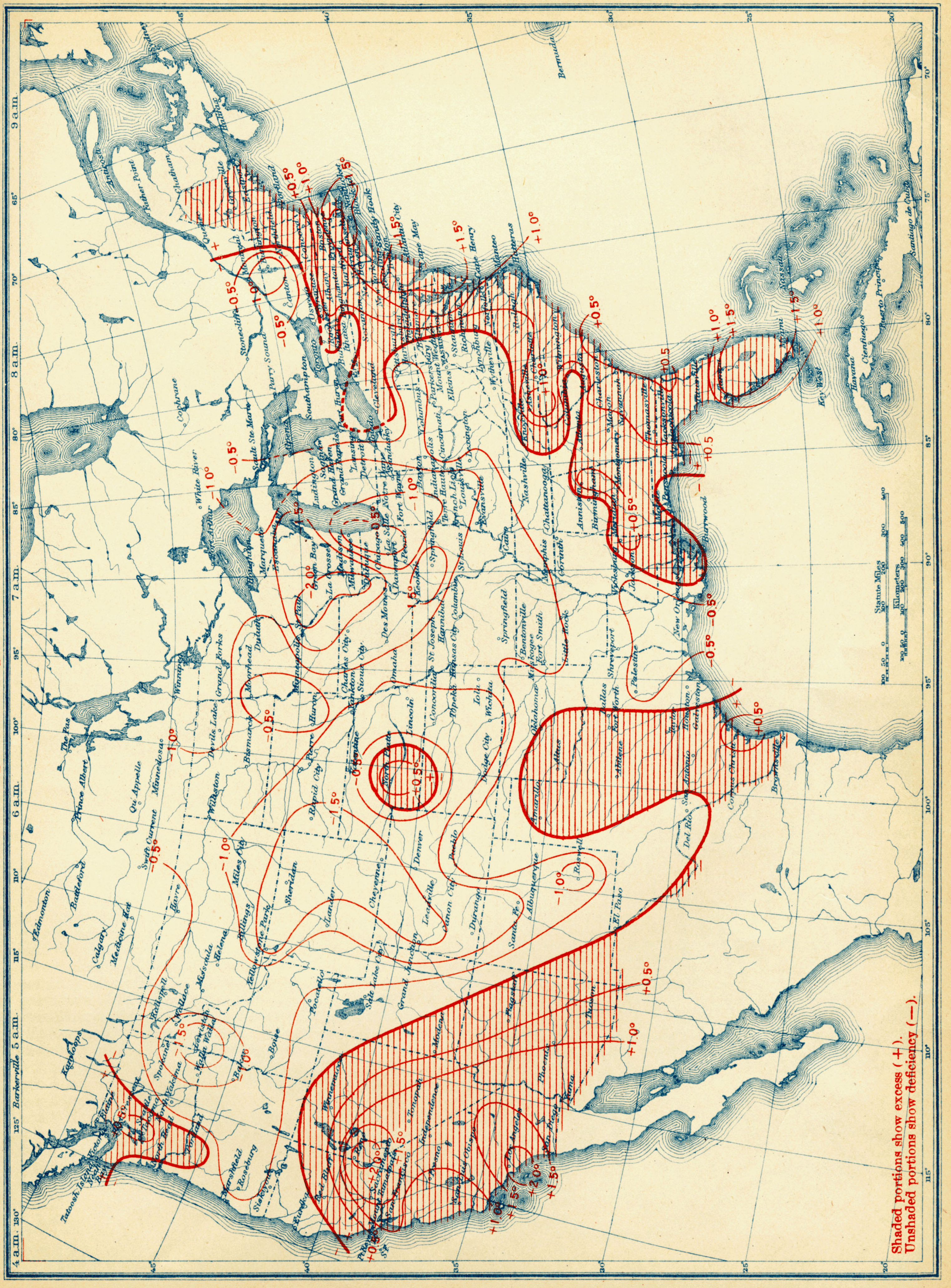
District	January	February	March	April	May	June	July	August	September	October	November	December	Year
New England	−0.2	+0.3	0.0	+2.3	+0.6	−0.8	−1.9	−0.8	−0.6	−0.7	−0.4	+0.4	−1.8
Middle Atlantic	−0.7	+0.6	−0.6	+2.0	+0.3	+0.4	−2.4	−1.9	+0.8	+2.1	+0.2	−0.7	+0.1
South Atlantic	+0.1	+2.5	+0.9	+0.1	+1.7	−0.2	+0.2	−1.2	+3.7	+2.1	+0.5	+0.3	+10.7
Florida Peninsula	−0.9	−0.8	+0.9	0.0	+1.5	−0.8	+2.2	0.0	+4.8	+3.9	−1.2	+3.6	+13.2
East Gulf	+0.8	+2.3	+5.8	+0.6	+1.3	+1.2	−0.8	−1.3	+2.8	+0.7	+4.5	−2.0	+15.9
West Gulf	+0.4	−0.9	+0.1	0.0	+4.9	−1.4	0.0	−2.1	−1.0	−0.5	+1.0	−0.4	+0.1
Ohio Valley and Tennessee	+0.3	−0.4	−0.3	+0.8	+3.1	+0.1	+0.4	−1.4	+0.6	+1.3	+1.1	−0.5	+5.1
Lower Lakes	+1.0	−0.8	+0.3	+3.0	+0.6	−0.8	+0.3	−1.1	−0.4	+0.7	+0.1	+0.8	+3.7
Upper Lakes	+1.5	−1.0	+0.3	+1.7	−0.3	−0.2	−0.8	−1.4	−0.9	+0.4	−0.9	−0.2	−1.8
North Dakota	+0.3	−0.2	+0.3	+0.2	−0.4	−2.0	−0.9	−1.3	0.0	+1.0	−0.1	+0.2	−2.9
Upper Mississippi Valley	+1.4	−0.3	+0.6	+1.1	−0.4	−0.3	+0.6	−1.1	−0.5	+0.4	−0.8	−0.7	0.0
Missouri Valley	+0.7	0.0	0.0	+1.4	+1.0	+0.1	−0.9	−1.4	−0.8	+2.2	−0.4	−0.7	+1.2
Northern Slope	0.0	0.0	+0.4	+0.8	−0.5	−0.8	−0.4	0.0	+0.3	0.0	+0.1	+0.3	+0.2
Middle Slope	+0.3	−0.1	+0.2	+0.6	+0.5	0.0	+0.5	−0.9	−0.2	+0.7	+0.4	−0.5	+1.5
Southern Slope	−0.4	−0.1	+0.6	−1.2	+0.8	−1.2	−0.3	−0.9	−0.4	+0.2	−0.4	−0.3	−3.6
Southern Plateau	−0.4	−0.2	−0.3	−0.3	+1.1	−0.2	+0.1	+0.5	+0.6	0.0	−0.2	−0.6	+0.1
Middle Plateau	−0.1	−0.2	−0.1	+0.4	−0.8	−0.1	+0.3	+0.1	+0.4	−0.5	−0.6	−0.4	−1.6
Northern Plateau	+0.3	−1.0	−0.4	+0.1	−1.0	+0.3	−0.5	−0.2	−0.4	−0.7	−1.4	+0.1	−4.8
North Pacific	−3.5	−4.0	−0.5	+0.2	−0.9	+0.5	−0.2	−0.3	−2.0	−1.8	−4.9	−0.2	−17.6
Middle Pacific	−2.8	−2.2	−1.9	−0.6	−0.9	+1.1	0.0	0.0	−0.6	−1.2	−2.8	−0.2	−12.1
South Pacific	−1.2	−0.9	−0.3	+0.1	−0.4	+0.1	0.0	0.0	+0.1	−0.6	−1.0	−1.8	−5.9
United States	−0.1	−0.4	+0.3	+0.6	+0.6	−0.2	−0.2	−0.8	+0.3	+0.5	−0.3	−0.2	+0.1

NOTES, ABSTRACTS, AND REVIEWS

Aspects of surfaces of discontinuity (*by C. K. M. Douglas* (*Roy. Meteorolog. Soc., J. 55, pp. 123–147, Disc., 147–151, April, 1929*)).—Among the chief points discussed are: (1) Factors tending to produce sharp fronts at the earth's surface. (2) Examples of sounding of upper air temperature through rainy fronts. It is found that the surface of discontinuity is normally smoothed through a layer about a kilometer thick, inversions being rare, especially in deep depressions. It is thought that some rain belts, with associated fronts resembling "occlusions," are developed in polar air, and are not strictly "occlusions" at all. (3) Warm sectors are not surface phenomena, but are of fundamental importance in determining the upper air conditions over depressions. The fall of pressure in the warm sector in a deepening depression must be due to the spreading over of air from higher latitudes in the upper part of the troposphere and in the stratosphere. The corresponding feature of a developing anticyclone is a spreading over of tropical air at high levels. (4) Subsidence is discussed quantitatively. The development of inversions with dry air above them (comprising a very large percentage of all inversions in the troposphere above 500 meters) is considered to be due to subsidence combined with turbulence up to a definite limit. Cloud particles and precipitation are important in preventing dynamical warming at a fixed level by subsidence. (5) Sixteen striking wind discontinuities observed by pilot balloons in the British Isles in the last nine years are given, with remarks on their relation with fronts and surfaces of subsidence. (6) Turbulence at sloping surfaces of discontinuity is discussed on the basis of a criterion due to L. F. Richardson. (7) The overrunning of warm air by cold air is referred to, and it is thought that except near the ground this takes the form of continuous rather than of discontinuous motion. It is shown that a vertical front of any appreciable magnitude must be very much

(To face p. 512)

A. J. H. **I. Annual Temperature Departures (°F.) in the United States, 1929**



A. J. H. II. Annual Precipitation Departures (inches) in the United States, 1929